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ORIGINAL ARTICLES.

ON THE PRIMARY CAUSATION OF ASTHENOPIA.

INFLUENCE OF FATIGUE.

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OPHTHALMOLOGISTS readily concur in the belief that refractive anomalies are strains producing sundry vicious disturbances; they differ as to what may be considered a border-line degree, within which the symptoms may be looked upon as systemic rather than peripheral in origin. They are not easily moved from their fixed individual positions with reference to the part the extrinsic ocular muscles play—whether apparent imbalances are primary or secondary, anatomical or functional, peripheral or central, and as to what importance attaches to them. The problem will never be solved until we study more into the causal factors.

To introduce the subject of fatigue and its effects into the etiologic consideration, in the February number of the *Ophthalmic Record* we called to mind points of analogy between asthenopia and the fatigue neuroses.

Almost exclusive consideration has always been given to so-called "eye-strain" as the etiologic factor *par excellence*. As to in what manner the strain acts in the production of the symptoms, I have not seen described.

In speaking of the fatigue neurosis, writers cramp, Gay

says: "The education of centers which may be widely separated from each other for the performance of any delicate movement is mainly accomplished by lessening the lines of resistance between them so that the movement, which was at first produced by a considerable mental effort is at last executed almost unconsciously. If, therefore, through prolonged excitation, this lessened resistance be carried too far, there is an increased and irregular discharge of nerve energy which gives rise to spasm and disordered movement. According to this view the muscular weakness is explained by an impairment of nutrition accompanying that of function and the diminished faradic excitability by the nutritional disturbance descending the motor nerves." And Lewis says: "There is a certain limit to which exercise of a given group of muscles may be carried without producing fatigue and local congestion and perhaps inflammatory results; this varies greatly in different individuals, but if it is continually and uninterruptedly overstepped and insufficient time given for rest and recuperation, the centers in the spinal cord which regulate the action of the various muscles become overstimulated and the result is an undue amount of nerve energy induced by the peripheral excitation and there is a distortion of the central impulses in passing through these centers, a perturbation of the coordinating power ensues and incoordination is the result. Under rest and appropriate treatment these symptoms may pass away, but if the part is continually used it is highly probable that nutritive changes will be produced in that part of the spinal cord from which the nerves supplying the overtaxed muscles proceed."

Roosa said of asthenopia: "I believe the general nervous condition, especially the nutrition of the nervous system, will have much to do in determining the causes of asthenopia. I point to the asthenopia following typhoid fever as an index of what is meant by this condition." Again, "it has been pretty clearly shown and is capable of wide demonstration that ametropia exists in at least 90 per cent. of the human race" arguing that muscular imbalance is invariably dependent upon heteropia; and "it must not be forgotten that neurotic patients will submit to any treatment, even to ocular tenotomies month after month and year after year, in the vain hope of finally achieving what is possible for some individuals, that is the use of the eyes as

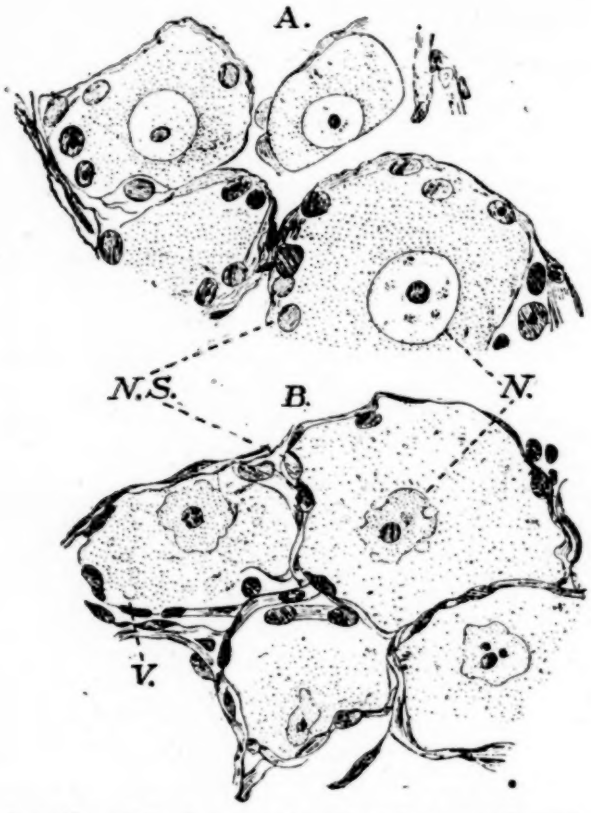
long as they choose, under all conditions, without any discomfort."

Dr. Stevens undertakes to account for all the diseases supposed by a few, with him, to be related to eye-strain, by excluding direct transmission of disease from parent to offspring, and he makes the proposition that such diseases "are the manifestations of transmitted physical peculiarities which render difficult the performance of certain important functions." And "that of the hereditary defects which thus tend to develop neuroses, anamolous conditions of the eyes are among the most frequent and important."

Of these quotations the first two refer to the etiology of an analogous condition primarily to abuse through excessive use, genuine fatigue disease; the third gives prominence to the predisposition; the fourth to the peripheral strain as the *sine qua non* of the affection. The subject is thus furnished us for consideration under the captions, fatigue, predisposition, and peripheral strain.

First, as to fatigue and its possible relationship. With the sensation of fatigue, bodily or mental, all are familiar. It is doubtless related to central nerve consciousness in a manner akin to the muscle sense concerning which little is known. Generally speaking, and from the psychical standpoint of consciousness, we may consider it as the call of the tissues for respite and recuperation. Whether we consider it to arise as the result of the stimulation of centers governing it or a special stimulation of nerve endings or centers, it is generally supposed that it occurs as the result of the formation of so-called fatigue substances the chemical nature of which, though in nerve centers not clear, is in muscle structure quite positive. For physiologists tell us that while no changes are demonstrable in nerve *fibers* as the result of even prolonged stimulation, nerve *centers* are known to develop an acid reaction as the result of activity or stimulation and these substances are supposed to be the direct cause of the fatigue. In addition there is increase in temperature, altered electric reactions and, with the microscope, certain clear and well defined alterations are apparent. Several observers have given definite demonstrations of these changes. Quite recently Hodge has beautifully shown that both the nerve center and nuclei after prolonged stimulation shrink in size, their edges become irregular

and both undergo changes in reactions to staining reagents, the cytoplasm staining less, the nuclei and nucleoli more deeply with osmic acid. Vacuoles appear in the body. These changes of activity are shown in the accompanying illustration,



Two sections, A and B, from the thoracic spinal ganglion of the cat. B, from the ganglion which had been electrically stimulated through its nerves for five hours. A, corresponding resting ganglion. The shrinkage of the structure connected with the stimulated cells is the most marked general change. N, nuclei. N. S., nucleus of the capsule. V, vacuole. Magnified 500 diameters.—HODGE.

demonstrating the effects of stimulation of the thoracic ganglion of the cat, which was stimulated fifteen minutes and allowed to rest forty-five minutes of each hour for five hours. Hodge has also shown that these are likewise the results of functional activity and are beyond doubt applicable to man.

Functional changes result, viz.: lessened irritability and weakened currents, the direct result of the former being altered reaction time evidenced by the slowed response to various stimuli after the partial using up of the potential energy, the latter necessitating increased stimulation to maintain an uniform strength of efferent impulse.

It is apparent then that what has been known of muscle for some time is coming to be known of nerve centers, that is, that they have within them stores of potential energy, unstable molecules, and that stimulation does not of necessity pass through them, it sets free this energy from center to center.

In muscle the acid products are known to consist of carbon dioxide, sarcolactic acid and acid phosphate of potash. It is thought that the acidity is responsible for the temporary loss of irritability. Under ordinary conditions, however, these substances, being soluble, enter the general circulation, and while freeing the place of origin affect other bodily functions, *e. g.*, the respiratory and cardiac centers as evidenced by their increased activity during exercise. Aside from this obviously the contractile material of muscle is used up—and an analogous condition in nerve centers is not doubted—by the activity; this is in some measure compensated by the increased blood supply accompanying the act under usual conditions of moderate use, entirely so by proper intervals of relaxation and rest. Important requisite for this complex contractile material first, oxygen, which, though not essential to the contractions, *per se*, enters in some way into the composition of the explosive material whose energy is set free by the nerve impulse; and second, pabulum.

Varying degrees then, from fatigue to exhaustion, may arise locally from: either the retention of fatigue acid substances in the muscle or nerve center, an excess of formation over the excretory capacity of the area, or the using up of the explosive material present through decomposition, excess of katabolic over anabolic activity, or a combination of both.

While it is quite clear that the products of the activity in the circulation produce the sensation of fatigue (the effect of transfusion of blood from a fatigue animal to the vessels of a rested one is proof of this) pathology gives some evidence that these substances, whatever their nature—and is probably quite complex—are related much to voluntary effort, that it is the

voluntary effort that wearies and not the contraction. In other words—a subject which has important bearing and which we shall later dwell upon—contractions independent of volition are not productive of conscious fatigue to any extent; hysterical contractures persist for long periods of time without even a sense of lassitude; we know by experience that the sensation of fatigue is different as between that resulting from nerve and that from neuro-muscular activity.

Use or the capacity to endure work without fatigue is relative to acquired capacity through use. So also the load lifted—the work done—has important bearing, and thus we have the following factors influencing fatigue, viz.:

(*a*) Preceding development; (*b*) Volume of disponible force; (*c*) Drainage; (*d*) The load.

(*a*) Tissues develop powers proportioned to their activities, due intervals for recuperation being allowed; more than this, develop a readiness to repair, commensurate to the needs and uses. Use fathers growth and development; so abuse, maluse or nonuse degeneration or waste. If requited by rest repair ensues and increased power supervenes. Fatigue will arise therefore inversely as the capacities of tissues are developed independent of all other conditions.

The blood supply has been thought to be an important factor to this. "Transient congestion is the law of physiological activity." Reactionary tonic contraction is the law of physiological rest and this alternation of vascular contraction and relaxation is the rythm of living, growing and useful tissue. In the light of recent investigations, however, these can not be looked upon as primary factors in the increased growth further than they are responses to the demands of the cells whose 'specific energy' through evolutionary and inherited tendency is that of adaptative growth. Exercise operates upon the nutrition of the cell doubtless through not only the blood, but the nerve supply as well. Donaldson, in speaking of nerve cells says: "If excitation falls below the point which causes this, *i. e.*, nutrition, the responsiveness of the cell is diminished, * * * the loss of the impulse which rouses the cell to activity is usually a more important condition than direct nutritive change and must for this reason always be kept in mind." Of the more direct bearing of this upon the causative

factors in the affections under consideration more may be said.[1]

(*b*) The volume of disponible force directly influences fatigue, as we have seen, and we have to consider: (1) The latent energy on hand preceding the work. (2) The maintainance during the activity of a degree of energy short of which fatigue begins.

(*c*) The drainage of products of tissue change strongly influences fatigue, as we have also seen. It is worthy of note that the mechanical effect of the elastic overlying tissue is a direct aid to this in all muscles in the external groups, an aid lacking in these muscles. The harmful effect of these products rests upon the well-known law that the products of a cell activity are toxic to that cell.

(*d*) The load lifted. Regardless of certain fundamental laws of tension, stimulation and vigor of contraction which will be later considered, the law of energy dissipation, of supply and demand, is in this instance paramount, and the direct effect of removal of the punctum remotum beyond infinity, the recession of the punctum proximum and other like static alterations, as well as the duration of time the load is held, are apparent.

These are so dependent upon what we shall consider under the head of predisposition and peripheral strain that little attention will be given here. We know that in walking, in the cardiac activity and other like rythmic and more or less automatic functions, action is intermittent and time is given for restoration of energy compounds in the protoplasm and to rid the area of waste products. "Sooner or later, however," as Lombard says, "the vigor of the muscle begins to decrease. The reason for this is not clear." While rythmical contracture is the rule in most mechanisms, in the use of the mechanism under consideration, the periods of relaxation are not rythmically intermittent, nor indeed in many cases developing the distress does the activity remit to any extent during waking

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[1]It is well known and upon it rests the superstructure of evolution through adaptation, that the developmental power of tissue in response to utility is almost unlimited. The power of a neuro muscular mechanism may indeed be increased by use and proper rest intervals even under unfavorable environment, capacities of function and reparative and reconstructive changes going on hand in hand to surprising degrees,

hours, obviously not at all, as we have before pointed out, in abnormal static states. However, the existence of even isolated cases of individuals who maintain the greatest degree of ocular work with a minimum of relaxation without fatigue and its exaggerations, allows us the conclusion that if metabolism and drainage are not interfered with, sufficient restoration is ordinarily being constantly made that the period of sleep suffices to complete the recuperation and replenish the stores of energy for a subsequent day.

Our four factors are themselves interdependent; each is relative to the other three. So closely too are the preceding development, the available energy and the drainage dependent upon the vitality, and the load lifted upon the peripheral abnormality that the causes of fatigue lead back to the causes of the disease under consideration, and the subject of fatigue and its exaggeration rises to a prominent place in the etiologic consideration. Indeed, it seems rather convincing that the products of fatigue (whether of nerve or of muscle) may be the elements of chief interest, the chemical stimuli in most cases of asthenopia and the many pathologic conditions related to ocular activity. Further consideration of the remaining propositions will show some reasons for this thought, Considering here, however, only fatigue and the influences of use, we have to deal first, with effects *in situ*, second, with resulting muscular incoordination, and third, with reflex effects arising symptomologically.

In other words, it is apparent that these causes may be operative anywhere throughout the visual-motor tract from the ideo-motor through motor centers to nuclei and muscles. And if you grant me space for theory I conceive that if these substances produce their effects in muscles alone, for instance, the first effect must be upon muscle power and tone, this may lead to disturbed muscle sense and to incoordination; so also if the effects be upon a center, like disturbances of muscle may follow or from any portion may stimuli be directed and following along lines of least resistance evidence their effects in terminal organs more or less remote.

As a matter of fact the work of physiologists goes to show that the muscle is the last part of such a tract to undergo the

effects of fatigue.[2] Whether it be proven that the center, more probably series of centers, having control of this most sensitive of coordinations lies in the tubercula quadrigemina; whether there be a center for convergence as shown by Adamueck and one for conjugate or associated lateral movements; whatever theories or demonstrations ultimately maintain, there must obviously be a coordinating mechanism, and as such it is the requirement of binocular vision in the first place and binocular convergence secondly, and has the higher functioning. In addition, we must assume as its correlative function, that of inhibiting antagonistic coincident with stimulating acting muscles.

Now that which is the lowest in the scale of development becomes the most independent, enduring, and indeed perfect in its functional activity. Hence, in the act of reading and like uses of the eyes this coordination which early requires the constant guardianship of higher centers comes through habit capable of independent action—and of necessity for its complex and rapid working—requiring only the stimulus to begin or the inhibition to cease or alter the coordination. When from any cause this reflex activity is impeded special direction becomes necessary and the higher centers not used to such effort are called into play and these from the very lack of adaptation become readily fatigued, greater effort and concentration becoming necessary as fatigue of the higher centers progresses. If then, we imagine the lower centers in a state of primary exhaustion when the higher stimulus is again directed and it is urged to further effort, there will surely come a time when, from excessive nervation, or from deficient functioning power, or both, incoordination will result. The stimuli will take diverse directions and establish for themselves courses over lines of least resistance; and not only may this result in incoordination through the misdirected stimuli, or failure to inhibit the antagonistic muscles, or fatigue of any other of its complex acts, but inhibit reflexes from the frequent repetition of a like process. Further than this, the time required for recuperation of such cells is greater as they are more exhausted;

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[2]If after exhaustion by voluntary muscular work the muscle be stimulated by the electric current, contraction will again result.

and it is not difficult to see wherein the at least functional weakness may become more or less permanent.

That the exaggeration of fatigue is pain and disordered movement anyone may prove by employing an unused group of muscles. Incidentally, it will also show that it is the effect on the coordinating and higher centers—the group mechanism—and not the muscles, for the latter may immediately be used for other purposes not only without pain but sometimes with apparent relief. Take the unusual act of holding the arm outstretched on a lateral plane with the body. Directly the muscles feel wearied, then painful, the experimenter becomes conscious of special direction, it is impossible to keep the attention from the act, the energy overflows into auxillary muscles, irritability will supervene and if it is possible still to continue the experiment the arm will fall exhausted or will exhibit spasmodic contraction; there will be neuralgic pains about the back and perhaps a general weakness will follow. An experiment more *à propos*, is that of adding a load to the ciliary or to the extrinsic muscles by employing a minus lens or a prism of moderate degree. If the work be voluntarily forced to extremes the effects, though varied as between individuals, will show the above exaggerations of fatigue and reflexes of various natures. In some temperaments the effects are more rapid, the pain and nervousness more severe; they will nevertheless be produced in the least neurotic or the most robust.

The amount of work of which a mechanism such as the oculo-motor is capable without fatigue and its exaggerations—all of which may well be included under the name *dyscinesia*—depends then upon the uses to which it has been previously put, which, with the environment during the developmental period, determines the condition at the time of beginning activity; second, the metabolic activity during the period of use—whether the ratio of anabolism to katabolism falls regularly or for any period of time; third, the removal of the products of metabolism; and fourth, the load lifted, determining within measure the energy loss. When the work begins to fail and special direction becomes necessary, fatigue as a consciousness really begins and the exaggerations quickly follow upon subsequent abuse. On this argument the pain, the ciliary spasm, the excessive or weakened contraction of an extrinsic muscle—heterophoria of a more or less stable degree or

kind—or the reflex and perhaps other supposed evidences of eye-strain may under certain conditions be the result of absolutely normal kinetic states, or a slight structural abnormality or vicious habit of use may be a sufficient added load to cause distress in the failure of the other essentials to normal use. Conversely by the perfect action of metabolism and drainage, otherwise excessive abnormity may be readily borne if only time has been given for adaptive development under favorable environment.

SOME OF THE PHYSIOLOGICAL FACTORS CONTRIBUTING TOWARDS MAKING THE EYE EMMETROPIC.[1]

BY E. S. HEISIG, M.D., HOUSTON, TEXAS.

[CONCLUDED FROM OCTOBER NUMBER]

But whether this mode of development be accepted or not the great fact admitted by the highest authorities remains that the hyperopia of infancy and childhood becomes less, may become emmetropia, and even go over to myopia. This is concurred in by such men as Noyes, Nettleship, Fuchs and others. For instance, Noyes ("Diseases of the Eye," first edition, page 81) says: "It is evident that the axis of the eye increases in higher ratio during the early years of growth than do the optical parts."

Now what regulates this action?

If this comparative elongation of the globe took place indiscriminately in all eyes during the growing period, all emmetropic eyes would become myopic; all myopic eyes would become more so, and even hyperopic eyes would seldom by mere change stop this action just at the point to make them emmetropic. The probability would certainly be that the action would either be insufficient or excessive, the eye thus either remaining hyperopic or becoming myopic.

The essential regulating factor I think we will find in the refractive state of the eye. This is easily explained if we ac-

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[1]Read by title before the South Texas Medical Association

cept the theory laid down as to how the elongation is brought about, and has in fact been to a certain extent anticipated.

Let us now more fully examine the regulating influence that the three refractive states of the eye known respectively as emmetropia, hyperopia and myopia exercise on this process.

The refractive state known as emmetropia or the ideal state of refraction for the eye, exercises an inhibitory influence on the process of physiological elongation, and this inhibitory action may be said to be in inverse ratio to the degree of hyperopia when this state of hyperopia exists. This is highly important and examplifies one of those wise provisions of Nature, for when the process has gone from hyperopia to emmetropia, to be beneficial it must cease. It does so in the vast majority of instances because the conditions producing the muscular action described are no longer present. The accommodation is no longer brought into play for distinct distant vision, in fact it would preclude such; the concommitant act of convergence and the antagonistic action to maintain the parallelism of the axes of the eyes, all of which as we have seen exercising compression of the globe, are no longer operative.

Under this inhibitory influence also the process of elongation is not started if the eye is already in a state of emmetropia. Of course, the fact is not lost sight of, that the emmetropic eye exercises its power of accommodation in proportion to the nearness of the object looked at, but this action is normally intermittent instead of constant, and if near objects occupy the greater portion of the waking hours thus substituting a continuous for an intermittant action even in this state, one of the causes that is capable of inducing an elongation of the eye is certainly put in motion, and is, I believe, generally conceded one of the most frequent causes of myopia. The extrinsic muscles are also called into action by the emmetropic eye, but the effort of convergence is in proportion to the nearness of the object viewed and the amount of accommodation exercised, and does not necessitate antagonism except a sufficient amount to steady the eye.

The influence which the refractive state of the eye known as hyperopia has on the process of physiological elongation of the axis of the globe, or rather on the muscular action producing the same has already been anticipated in describing the process itself. It may not be amiss, however, to briefly allude

to it again. The hyperopic condition of refraction necessitates the use of accommodation for distinct vision of even the most distant objects and an excessive amount for near ones. The amount of accommodation for objects twenty feet distant or more, and the excess over the normal for all nearer objects is in direct ratio to the degree of hyperopia. But to a given amount of accommodation exercised a certain amount of effort of convergence will unconsciously be a concommitant, and as in looking at distant objects practically no convergence of the visual axes is tolerated, this in its turn necessitates the action of muscles to counteract this effort of convergence. In viewing nearer objects the excessive amount of accommodation required will also produce too great efforts of convergence, which will have to be overcome in the same way.

This description of the action of the extrinsic muscles of the eyes in hyperopia finds strong confirmation in the fact that this condition furnishes the greatest number of cases of convergent strabismus.

Hence we see that the condition of hyperopia favors this process by which a physiological lengthening is brought about. And I will, at the risk of the charge of repeating, lay stress on the fact that in this condition the muscular action described is continuous, not only during the waking hours, but in consequence of spasm of accommodation, which all authorities admit exists nearly always in this state and called by them latent hyperopia, that part of the process goes on even during sleep. In the emmetropic eye as is well known the condition of comparative muscular rest exists except when exercised on objects nearer than twenty feet. It is true the muscular action which brings about this elongation of the antero-posterior axis of the eye is not as active during the sleeping as during the waking hours, but we might metaphorically say that the action during sleep is sufficient to hold the advance made during the waking hours next preceding until the succeeding waking hours with its increased action shall carry the process still further This continuous action has further importance in view of the fact that any organ certainly has at least a tendency to develop permanently the form in which it is held for a protracted period of time even after the force so holding it has been withdrawn. This is so self-evident than it forbids further notice here.

Finally, let us examine the influence exerted by the state

of refraction known as myopia. This influence will be found to be in part the same as that in emmetropia, and the more so the more the condition approximates emmetropia, *i. e.*, the lower the degree of myopia the more nearly will the influence be the same, or the less will be the effect of the new elements considered below. This is in some respects unfortunate as the higher degrees require this influence the most, but as the degree increases other factors present themselves and to these other factors is due the fact that the inhibitory action is frequently entirely perverted in this state. Let us examine this more closely. As we have said the lower degrees when uncomplicated by new factors practically exert the same influence as emmetropia. But this simple inhibitory influence as exercised by the emmetropic state of refraction must be often absent, and hence we often find the influence insufficient or entirely perverted, and the tendency of the refractive error to increase. The disturbing factors I shall now mention are those acting through the extrinsic muscles, and the intrinsic muscle of the eyes. In myopia an excessive amount of convergence is required both relative and absolute. Absolute when the ametropia is sufficient to necessitate the bringing of the object closer to the eyes than normally required, and relatively in proportion to the amount of accommodation exerted. The latter is probably the more important of the two as it must always be borne in mind that a strong sympathy exists between the two acts, and that this sympathy is reciprocal, *i. e.*, that not alone does the act of accommodation induce involuntary effort at convergence, but that the act of convergence induces efforts of accommodation. That the latter takes place finds confirmation in the fact recognized by most oculists, that the apparent myopia is frequently more than the absolute. But this increase of accommodation will necessitate still stronger efforts at convergence in the higher degrees of myopia as the object will have to be brought nearer to the eye. If the above be correct we can understand how, although in myopia it has always been taken for granted that accommodation is very little exercised, that this is true only in regard to the range of accommodation, but that in reality it is in a constant state of exercise compared with the emmetropic eye. These two factors then, a continuous, although limited action of the ciliary muscle instead of an intermittent one, and the excessive and al-

most constant action of the extrinsic muscles, both brought about by the myopic state of refraction readily explain, I believe, the tendency of the myopic eye to become more so. For these are essentially the conditions obtaining in hyperopia, *i. e.*, the eyeball is constricted between the two poles of the eye, and this must of necessity tend toward its elongation. In the case of hyperopia the process is one of physiological development, while in myopia it is rather one of over-stretching, the posterior part of the eye giving way as being the weakest point.

To the results of the action of the extrinsic muscles already described in myopia must be added that in extreme convergence of the visual axes there must be a corresponding divergence of the posterior poles of the eyes which will in its turn be more or less interfered with by their attachment to the optic nerves at this place. This resistance offered by the entrance of the optic nerves causes the condition known as the myopic crescent in which there is a giving way, or at least a changed relation of the tunics of the eye at this point. The continued action of even moderate convergence such as occurs when persons with emmetropic eyes are engaged too much with near vision probably exerts a like action. In fact, this substitution of continued instead of its normal intermittent action in all its varieties can not be too strongly dwelt upon.

In the case of hyperopia then, the process of elongation being a physiological and compensatory one, let us enumerate a few of the requisites, the absence of which may interfere to a greater or less degree with its full development.

1. An instinctive desire and capacity for comparatively continuous distinct distant vision. This is imperative, as without this the process described is either not put into continuous active operation, or is not perfectly regulated. The failure of this prerequisite may be due to extreme degrees of error, to a low grade of visual acuity, to a certain functional incapacity of the muscles of the eyeball, the effort in each of these cases for continuous distinct distant vision being too tiresome to keep up. The failure of the same may also be due to what may be called mental inaptitude.

But as we have seen, the process may prove excessive, and what was physiological and conservative in the first instance may become secondarily pathological and detrimental.

I will only briefly allude to one or two of the causes that may bring this about, as I am afraid I have already taxed your patience too much.

One of the main causes is the excessive use of the eyes on near objects, especially during the period of growth, an indoor life alone precluding distant vision aiding largely. It is now in the light of what has been said easily understood how this is brought about if we bear in mind the refractive influence of emmetropia on the physiological elongation of the eye when the eye is engaged for the most part of the time, as it normally is, in distant vision. This influence as pointed out is an inhibitory one by suspending the continuous and excessive muscular action by which the process is carried on. But this inhibitory influence is only exerted when the eye is either functionally inactive or is engaged in distant vision, hence if we are constantly occupied with near objects this inhibitory influence is suspended, and the process described is too actively carried on.

Another cause is spasm of accommodation from whatever cause as the process reaches the emmetropic line thus acting in the same way as the myopic state of refraction already described; in other words, the action is no longer under the control of the regulating influence of the normal refractive quality of the eye as a state of myopia is artificially induced.

There is another cause that may be said to act passively, namely, a weakened condition of the tunics of the eyeball, especially the sclerotic coat.

To conclude this paper I offer the following as a summary of what has been attempted to be maintained:

1. That the vast majority of eyes at birth are hypermetropic.

2. That the ideal state of the fully developed eye is emmetropia, and that hence the eye at birth and for some time thereafter must be considered as passing through a stage of development, functionally or physiologically, as well as anatomicaliy.

3. That the primary cause tending towards making the eye accurately emmetropic after birth is the instinctive desire and effort for continuous distinct vision of distant objects.

4. That the secondary cause is the tendency of the eye in common with other organs, especially during the period of

growth to develop the form in which it is held during a protracted period of time and that this form will be found to be that in which parallel rays of light are accurately focused on the retina, because during the greatest part of the time the eye is normally engaged with distant vision.

5. That this form is physiologically developed by muscular action regulated by the refractive quality of the eye.

6. That this compensatory action may be insufficient, in which case the hyperopia remains, and that this is most frequently caused by failure of continuous distinct distant vision, which in its turn may be due to extreme degrees of the error, to a low grade of visual acuity, or to mental inaptitude, in all of which the effort of distinct distant vision is too tiresome to be kept up.

7. That this otherwise conservative action may overstep the physiological boundary and become pathological, in other words, prove excessive, in which case myopia with its concomitant evils is produced, and that this is most frequently caused,—first, by the excessive use of the eyes on near objects especially during the period of physiological development, or by spasm of accommodation in which the action is no longer under the control of the regulating influence of the refractive quality of the eye; and, secondly, passively, by a weakened condition of the tunics of the eyeball.

A PLEA FOR MORE MILD TREATMENT OF THE CONJUNCTIVA.[1]

BY E. W. AMES, M.D., CANTON, ILL.

IN presenting "A Plea for More Mild Treatment of the Conjunctiva," I desire to state that I advocate no drugs which have not been numbered among the multiplicity of remedies used in the treatment of affections of the conjunctiva. The combination of drugs which I advocate has been used by me in the treatment of acute catarrhal conjunctivitis, chronic

[1]Prepared for the Second Annual Meeting of the Western Ophthalmological, Otological, Laryngological and Rhinological Association, held in St. Louis, April 8–9, 1897.

catarrhal conjunctivitis, follicular conjunctivitis, phlyctænular conjunctivitis, and trachoma, with its accompanying pannus.

I shall not dwell upon the symptoms, course, etiology and complications of these diseases, except as it may be necessary to illustrate therapy.

The remedies which have found most favor and stood the test of time are the salts of zinc, copper sulphate and silver nitrate, together with some one of the antiseptics. Each of the remedies mentioned is an irritant astringent, and when used in such strength as to be potent for the chronic forms of inflammation, the reaction following the application is long continued and painful.

Relapses with exacerbation of the inflammation while under treatment are the common experience of every oculist. This always necessitates discontinuance of the astringent remedy until the eye recuperates from the intolerance which it has manifested. While the eye is undergoing this revolt the lesions are often re-established with such remarkable rapidity that when the oculist again ventures an aggressive treatment he may find the condition as far from cured as when the treatment was first begun. The remedies above referred to can not with prudence be placed in the hands of the patient to be used at home. Thus really curative treatment can be applied only at the office and therefore much time, valuable to the patient, may be lost.

To illustrate the treatment which I wish to recommend, we will consider a patient with a severe attack of acute catarrhal conjunctivitis. The secretion has become muco-purulent, the lids are sealed in the morning and there is the characteristic itching, photophobia and pain. The conjunctival sac should be flushed with a solution composed of formalin one part to two or three thousand part of boiled water. The upper lids are then raised or everted and the fornix conjunctivæ filled with a solution composed as follows: Boric acid gr. v, tannic acid gr. lxxx, glycerin fl℥ iv, distilled water sufficient to make fl℥ j. The pain from the application of this solution is quite severe, but lasts only from one-half to one minute; the patient then only complaining of a "sandy" sensation. The conjunctival vessels become intensely injected, but this rapidly subsides, and in twenty or thirty minutes the membrane is paler than before the instillation, the eye feeling cool and soothed.

The patient may be provided with a vial of each solution and instructed to use the drops every two or three hours when awake. On the following morning there will be but little secretion, the lids not being sealed, and the eye a useful organ. Under this treatment complete recovery takes place in two or three days, providing the acute attack has not been grafted onto a chronic condition. Our authors acknowledge that under the treatment usually recommended this disease is but slightly shortened in its course, the principal aim of treatment being to prevent a chronic inflammation as a sequel.

The merit of a therapy can not be estimated when the experiment is confined to diseases which tend to spontaneous recovery; hence I will devote the balance of my paper to the consideration of trachoma.

CASE 1.—About two years ago I was consulted by a poverty stricken individual who was suffering with trachoma of several years' standing. He was 50 years of age, used tobacco in quantity and manner peculiar to an inhabitant of the Missouri river bottom. Vision and photophobia were such that it was with much difficulty that he performed his farm work. The margins of the corneæ were covered with pannus. The lids were lined with a thick coat of granulations and entropion was quite marked. He asked for a prescription stating that he was unable to pay for such treatment as he should have. I prescribed a solution containing boric acid gr. v, tannin gr. xxx, glycerine fl℥ ij, and water sufficient to make fl℥ j, and directed him to drop one or two drops in each eye, four times daily, stop the use of tobacco, and when he could afford a proper fee, come to me for appropriate treatment. About four months after this I met him on the street and noticing that he wore his hat well back on his head, having no intolerance of light, I accosted him and learned that he had been having my prescription refilled and had used it faithfully. The pannus was gone and the corneæ were clear. I did not examine the lids.

CASE 2.—November 14, 1896, I was consulted by Amos W., aged 34 years, farmer. History, left eye sore frequently since a boy at school. Eight months ago the left eye became much worse and the right eye also became affected. Had been treated most of the time since that date. Vision, $^{20}/_{0}$ either eye. Diagnosis, trachoma either eye, pannus either eye, worse

on left; leucoma, left in pupillary area. I advised him to stop the use of tobacco (which he did not do), and as he lived ten miles distant, I provided him with a solution composed as follows: Boric acid gr. v, tannic acid gr. xij, glycerine f℥j, water sufficient to make f℥ss. Directions, drop two or three drops in each eye four times daily. He reported at my office two or three times each week, when I cleansed the conjunctival sac with the formalin solution and instilled a saturated solution of tannin in equal parts of glycerine and water. All of the distressing symptoms subsided in three days, the pannus cleared away, and two months from date of beginning treatment I discharged the case, cured. He recently came to my office and I found that the cure has remained permanent; the lids were thin and pliable, there being no cicatricial contraction which often occurs as a result of strong caustics more than as a result of the disease itself.

CASE 3.—December 15, 1896, I was consulted by J. R. R., aged 55 years; occupation, had been running an emery-wheel in plow shops for sixteen years. During February, 1896, he was compelled to quit his work on account of trachoma. He was treated a short time by his family physician who then advised him to go to the Illinois Charitable Eye and Ear Infirmary. He was treated at the Infirmary four months with some benefit and was sent home, seemingly, on account of the institution being overcrowded. His eyes beeame rapidly worse. He consulted a local oculist who treated him four months. Complaining that he received no relief he was discharged with directions to bathe the eyes in hot water several times daily. He followed this advice for about one month, at the end of which time he consulted me with the eyes in the following condition: Vision, either eye, $^{20}/_{CLX}$. Slight entropion of right lower lid. Entropion of left lower lid quite pronounced. Puncta in very good position. Epiphora marked, both eyes, with a profuse muco-purulent secretion. Pannus slight of right cornea and quite intense of left cornea. The right upper and lower lids were lined with a thick layer of trachoma granules. The left upper lid was much worse in this respect, having a cauliflower appearance. The patient remained at my office during hours and I treated him as heretofore indicated from three to six times daily. He was provided with a weaker solution of the depleting astringent which he used at home morning and

evening. The purulent secretion had ceased by the second day. At the end of the first week of treatment the vision of the right eye was $^{20}/_{XLV}$, vision of left eye, $^{20}/_{LXX}$. At the end of the second week the tarsal cartilages were shining through, there being here and there a little tuft of granulations. I now allowed him to resume work in the dusty shop, treating him once daily. At the end of six weeks from date of beginning treatment the granulations were gone, there being only a slight roughness of the tarsal conjunctivæ. The epiphora still continued. A marginal pannus which existed at the beginning of treatment had cleared away.

I for some time saw the case but once or twice a week, when I probed the nasal ducts, having the patient use only a 1 to 3000 formalin solution at home. Though I was able to pass a No. 6 probe through the nasal ducts to the floor of the nostrils, the epiphora continued. A slight roughness of the tarsal conjunctivæ persisted and with a tendency to increase after the astringent treatment was abandoned. Upon examination of the nostrils I found some hypertrophy of both inferior turbinated bones, septal spur right and anterior, and hypertrophy along base of septum on left. I removed the spur with a saw and reduced the other hypertrophied parts with the galvano-cautory. When the reaction from the operation subsided the epiphora became promptly relieved. The slight exacerbation of the conjunctival trouble subsided promptly under a few treatments of the depleting astringent.

I think in this case there not only existed an increased quantity of lachrymal secretion which was caused by reflex irritation from the rhinitis, but there was an actual mechanical obstruction at the lower orifice of the nasal duct due to turgescence of the mucous membrane in the inferior meatus. I believe oculists do not pay sufficient attention to this condition. There are surely many cases in which mechanical obstruction exists that can not be accounted for by either stricture or a flaccid condition of the membrane within the duct. It is reasonable to suppose that stenosis can occur at the lower orifice of the nasal duct from causes analogous to those which cause primary closure of the lower orifice of the Eustachian tube; yet how many of these cases are treated long and patiently without attention being given to the nostril?

I have many other cases which I could report, but the

ones which I have cited illustrate that a mild, depleting astringent and antiseptic therapy for trachoma is worthy of your consideration.

There is no disease of the eye regarding which such a mass of literature has been produced as on trachoma. This is accounted for by the fact that no satisfactory treatment has been secured. Severe cases have been cured, but the treatment extended over many months and often years; and oftimes the result of the treatment is a cloudy cornea or a cicatricial lid which leaves the patient disfigured for life. Mild treatment has been used as a matter of necessity as an adjunct to the trachoma forceps, a brush, or caustics; but I wish to emphasize the fact that the mild treatment which I have indicated will speedily cure the severe cases and is not in itself harmful to the eye.

Some of the advantages of the treatment may be summed up as follows: It is quickly curative. It promptly relieves the distressing symptoms. It can be repeated many times daily, thus obtaining a rapidly curative action. It is so mild that it does not interfere with the occupation of the patient, and may with safety be placed in his hands for use at home, thus securing a continuous therapeutic effect. Keratitis does not contraindicate its use. There are no evil sequelæ to the treatment such as argyrosis, and cicatricial contraction. No relapses occur on account of an intolerance of the membrane, necessitating suspension of aggressive treatment.

SUBCONJUNCTIVAL INJECTIONS OF SODIUM BICHLORIDE SOLUTION IN THE TREATMENT OF IRITIS, KERATITIS, CYCLITIS AND CHOROIDITIS.[1]

BY S. L. LEDBETTER, M.D., BIRMINGHAM, ALA.

I HAVE selected this subject, not for the purpose of airing my own views, nor because I have had a very extensive experience, for I have not. I have noticed from time to time,

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in current literature, references to the bichloride injections in the treatment of certain eye troubles; a treatment introduced by Drs. Abadie and Darier of Paris. But outside of Dr. Briggs' paper, read before the Ophthalmic Section of the American Medical Association in 1894, and some short notices by Dr. May in his "Reviews of Current Literature," there does not seem to be anything of consequence in our American journals.

Last year, however, Dr. Veasy had published in the AMERICAN JOURNAL OF OPHTHALMOLOGY an article entitled "Subconjunctival Injections of Sodium Chloride as a Substitute for the Bichloride Solution in the Treatment of Certain Eye Troubles." He claimed to get equally as good results and a great deal less pain from his salt solution. His reasoning seemed good, and the results so flattering, that I decided to give the treatment a trial. I have done so and will report the results in a few cases. I shall not select them from cases which have done best, but just as they came. In some instances the cases were not kept under observation long enough to make anything of them and so are not available for a report. They of course will have to be omitted.

CASE 1.—The patient, a young girl, with subacute iridocyclitis. The trouble was sympathetic and had been operated upon several times with a view to restoring the obliterated pupil, but to no purpose, each operation leaving the eye in worse condition than before. The fibrous deposit on the iris had grown to be very extensive and the circumcorneal injection never seemed to clear up entirely. I decided that I would attempt no further operations until this ciliary irritation had entirely subsided. Then I began the subconjunctival injections of salt 1 to 500. Only three or four were given, when the patient returned to her home. A month or so later she came to see me again. The eye was perfectly clear. The lymph deposit had narrowed itself down to one heavy, dense band running across the iris.

CASE 2.—A young boy, brought to me a few months ago, with a traumatic iritis and cataract. The pupillary margin was adherent to the lens capsule. The inflammation was considerable and had existed for a month or more. I ordered a solution of atropia and began the saline injection. In two weeks the inflammation was entirely gone, and the pupils partially dilated. The cataract of course was still in force, but the re-

covery from the inflammatory condition was prompt and satisfactory.

Cvse 3 —A negro man, aged 40 years, came to see me the past winter with chronic iritis, of syphilitic origin. Both eyes were involved and in each there was complete posterior synechia. The pupils were contracted to the size of a small pin-head. A few weeks of the subconjunctival injections, and the inflammation, which had existed for several months, was gone. Under the influence of belladonna the pupillary adhesions were partially broken up, but did not melt away as they did in some of Dr. Veasy's cases.

Case 4.—A young woman came to see me on November 14 of last year with a choroiditis of the left eye. She could count fingers with difficulty at six inches. The vitreous was so clouded that the ophthalmoscope could not be used. Three months of the usual treatment brought the vision up to counting fingers at three feet. On February 10, I began the saline injections. March 3, she counted fingers at ten feet. The vitreous is still full of small floating bodies, but the vision is rapidly improving. She has now (April 1) vision of $^{15}/_{0}$.

Case 5.—A young negro boy came to me February 19, 1897, with what seemed to be a clear case of interstitial keratitis. I gave him three or four injections. The inflammation subsided. The trouble disappeared as if by magic. This perhaps was the most remarkable recovery of all. Two weeks' treatment, all told, and the eye was practically well.

Case 6.—Mrs. D., white, aged about 35 years, developed syphilitic iritis in January. The usual treatment for such troubles was prescribed and the case progressed nicely for a while, then the condition became alarming. The iris was covered with lymph, the aqueous was muddy, and the cornea steamy and filled with exudates. The vision was reduced to perception of light. Pain and photophobia were intense. I began the saline injections, giving them daily for a few days, then every other day for a while. In a week the eye was free from pain, no photophobia, the pupil dilated except below where the effusion was very extensive; could count fingers across the room. The progress was phenomenal, but another relapse came, the eye was apparently as bad as before, and the same treatment was adopted. The eye eventually cleared up, but not as rapidly as before.

I have used the saline treatment in a number of other cases. In phlyctenular ulcers where, under the usual methods a cure can be expected,—in a reasonable time anyway. Some cases have been imperfectly kept up with and so can not be utilized in a paper.

As stated in the beginning, this paper is intended to promote discussion and to get an expression from those who perhaps have had a more extensive experience with the treatment than I. If there be any good in the treatment, if it has any therapeutic value, I would like to know it. As there seems to be no harm in it, I shall continue to use it in all cases where other measures seem slow and unsatisfactory, or until its efficacy be disproved.

SUBCONJUNCTIVAL INJECTIONS OF BICHLORIDE IN THE DEEP-SEATED DISTURBANCES OF MYOPIA.[1]

BY FRANCIS S. KELLOGG, M.D., LOS ANGELES, CAL.

I TAKE this opportunity to briefly report two cases of myopia complicated by choroidal and retinal involvement in which injection of bichloride gave marked relief.

CASE 1.—Mrs. A. B., aged 57 years; has worn —6.50 sph. both, for many years. Is delicate, of nervous temperament, and looks much older than she is. First consulted me in December, 1893. At that time she reported that five years previous she began to notice, when going from the light into the dark, a bright light before the left eye, which would gradually fade away. This phenomenon continued to grow more marked during the next three years. At the end of that time she says that a dark cloud, tipped with bright points rose suddenly from below. Three months later an object, shaped like a fan, seemed to encroach from the inner angle of the eye. It was of a dark bottle green color and "covered the sight in one month." (Detachment of the retina). Since that time she has

[1] Prepared for the Second Annual Meeting of the Western Ophthalmological, Otological, Rhinological and Laryngological Association, held in St. Louis, April 8-9, 1897.

been annoyed by phosphenes in this eye which take the appearance of a bright light running in a circle, and always from without inward.

Present condition (*i. e.*, at time of first consultation): Tension of left eye slightly minus. Pupil contracted to the size of a small pin-head and adherent to the lens, which is calcareous. No l. p. The eye is often quite sensitive to touch and the phosphenes are very trying, being always worse at such a time. Right eye, for the past month has noticed a bright crescentic figure of light in this eye, which comes and goes. Also floating films before the eye. Reports that glasses were increased in strength to — 8.50 one year ago.

The appearance of phosphenes in the right eye naturally gave rise to great solicitude for fear her experience with the left eye was to be repeated in the right. Dilatation of the pupil at this time showed peripheral opacities in the lens, posterior staphyloma and some opacities in the vitreous.

I adopted a systematic course of injections of bichloride, 1 : 1000, under the conjunctiva, at intervals of one week. The relief was immediate. The phosphenes were diminished in intensity so that they ceased to annoy as long as the injections were kept up. The irritability of the right eye seemed clearly to depend to a certain extent upon that of the left. This was demonstrated by the fact that the phosphenes in the right eye were controlled by the injections in the left. After a time, at the suggestion of a writer in one of the journals, I reduced the strength of the solution to 1 : 15000. The stronger solution was followed by considerable reaction which was avoided by the weaker, which seemed to be eqally effective.

The evident sympathy of the right eye in the irritation of the left together with the recurrence of phosphenes in the latter whenever the injections were omitted, led me to advise enucleation of the blind eye. This was done June 10, 1895. Since that time the right eye has given very little trouble. There has been no progress in the myopia and only feeble returns of the phosphenes. These have been easily controlled by the injections, the patient always presenting herself at such times.

CASE 2.—Martha F., aged 20 years. Myopia complicating exophthalmic goitre. She came under my care in May, 1895. She reported that a few weeks before she noticed a spot be-

fore the right eye about the size of a pear and of a green color. This remained stationary for two weeks when it increased in one night to tho size of a dollar. At first she could see through it, but after its increase in size it lost its transparency. Ophthalmoscopic examination disclosed myopia of 9 D., a posterior staphyloma and two small hæmorrhages in the region of the macula. The condition of the left eye was identical except for the hæmorrhages. At the time treatment of the right eye began the "green spot" or scotoma had become partially transparent. There were also phosphenes in this case. She was put upon injections of bichloride, 1 : 15000, twice a week. The phosphenes at once disappeared and the vision of the right eye improved so much that she could see better with it than with the left. This may have been partially due to the absorption of the hæmorrhage, in the course of nature, but I am inclined to give the injections credit for assisting in bringing this about. Constitutional tonic treatment was also given and the goitrc treated with injections of protonuclein special. Under this treatment the circumferencę of the neck was reduced from 33 cm. to 31 cm

A CASE OF OPTIC NERVE ATROPHY TREATED BY INHALATIONS OF NITRATE OF AMYL.[1]

BY CHARLES W. KOLLOCK, M.D., CHARLESTON, S. C.

ON JULY 10, 1896, Wm. M., white, aged 63 years, consulted me on account of blurring of the vision of the right eye, which, he said, had been noticed for a month, and was gradually increasing. He was a strong, large-framed and muscular man, of Scotch descent, and in good health. He had used tobacco constantly for many years and was a moderate drinker of whiskey. The heart was in good condition and the blood vessels were no harder than would be expected in one of his age. The external appearances of the eyes were normal and the pupillary reflexes were good. R. E., V., $^{15}/_{cc}$, and with + 2.50 D. $^{15}/_{LXX}$. L. E., V., $^{15}/_{c}$, and with + 2 D. $^{15}/_{XV}$.

[1]Prepared for the Second Annual Meeting of the Western Ophthalmological, Otological, Laryngological and Rhinological Association, held in St. Louis, April 8–9, 1897.

With + 4 D. the left read Jaeger No. 1 with ease. The ophthalmoscope showed the right disc slightly hazy, a little swollen and with veins somewhat engorged. The specific gravity of the urine, which was normal in appearance and quantity, was at the first examination 1010, but within a day or two became 1020 and has remained so. No albumen or sugar has beeen found at any time. The field of vision was concentrically contracted, but there was no scotoma and the color perception was at all times good. He was given ten grains of iodide of potassium before each meal, and this dose was gradually increased until he took sixty grains a day, when the stomach was upset. In the meantime strychnine (sulphate) was prescribed, beginning with one-twentieth of a grain and gradually increasing until he took one-tenth of a grain three times during the day. The vision did not improve, but slowly decreased, until he could barely see $^{15}/_{cc}$ with + 2.50 D. The disk became whiter and more distinct and the arteries contracted visibly. It should have been stated that tobacco and alcohol had been interdicted and given up from the first. As the vision continued to fail and the nerve to become whiter it was decided to try the effect of nitrite of amyl.

On September 26, more than two months after his first visit, he was allowed to inhale the vapor of a few drops of nitrite of amyl that had been placed upon absorbent cotton. Before inhalation the vision with + 2.50 D. was $^{15}/_{cc}$. The face immediately became suffused and the ophthalmoscope showed the arteries of the disk larger and small branches, before invisible or nearly so, were easily seen. The vision was tested within a few minutes after inhalation and was found to be $^{15}/_{xxx}$ with difficulty. Twenty minutes later the retinal vessels had returned to their former condition, but the vision was, if anything, a trifle clearer.

September 28. Vision rather better than $^{15}/_{cc}$. Four minutes after beginning inhalation vision became $^{15}/_{lxx}$, $^{15}/_{l}$, and ten minutes later $^{15}/_{xxx}$?, but did not improve beyond this.

September 29. Before inhalation one letter of $^{15}/_{xxx}$; afterwards better.

September 30. Before inhalation $^{15}/_{xl}$ and $^{15}/_{xxx}$?; after, $^{15}/_{xxx}$.

October 2. Before inhalation $^{15}/_{xxx}$?; after, one letter of $^{15}/_{xx}$.

The inhalations were continued daily until the head symptoms became so disagreeable that it was thought best to discontinue them for a time, especially as the vision remained at $^{15}/_{xxx}$. He was then advised to take up the strychnine, which had in the meantime been left off. The vision remains at $^{15}/_{xxx}$, the disk is white but the atrophy has not increased nor have the blood-vessels become smaller. There was no scotoma, but a concentric narrowing of the field, which did not change materially after the inhalations of the drug.

REMARKS.—It is a well-known fact that nitrite of amyl causes a rapid improvement in vision in cases of tobacco poisoning, but the improvement is followed by almost as rapid a diminution. This case does not seem to have been due to the use of tobacco and alcohol, because only one eye was affected and there was no central scotoma or red blindness. Even if tobacco and alcohol were the causes the rapid and lasting improvement after the inhalations of nitrite of amyl, when no improvement (but gradual diminution) of vision had followed the use of iodide of potassium and strychnine, is exceedingly interesting.

THE ETIOLOGY, PROGNOSIS AND TREATMENT OF EXOPHTHALMIC GOITRE.[1]

BY J. FRED. CLARKE, M.D., FAIRFIELD, IOWA.

THE author had sent letters of inquiry to all the counties of Iowa and had collected 49 cases of Graves' disease. These were tabulated and showed the following points of interest:

(1) As to sex, 36 were females and one male. Of the 12 remaining all were probably females.

(2) The age ranged from 15 to 45 years. The greatest number in one decade being from 20 to 30 years of age.

(3) There was exophthalmos in all but one case, and in one case only was the exophthalmos unilateral. In two cases

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the right eye was more prominent and in two cases the left protruded more.

(4) The thyrioid was enlarged in all cases. In 9 cases the right lobe was larger than the left and in but one case was the left the larger.

(5) The pulse rate varied from 96 to 180. In but one case was there an organic lesion.

(6) The reported etiology was: Unknown, 22 cases; anxiety and grief, 11 cases; heredity, 5 cases; fright, 3 cases. Overstudy, exhaustion from disease, masturbation and ovarian and uterine disease were reported as less frequent causes.

(7) The treatment varied widely. Rest, strophanthus, digitalis, ergot, belladonna, strychnia, iodine, electricity, nuclein and thyrioid extract were all used. Thyrioid extract, strophanthus and rest seemed to be the most successful.

(8) As to the result of the 49 cases, 18 were cured, 16 improved. There were 5 deaths from the disease and 3 from intercurrent disease.

(9) The disease is rare in Iowa. After much correspondence but 65 cases were found and of these but 49 with sufficient data to tabulate. One physician in forty-five years and one in twenty-two years had not seen a case. The greatest number found in any one locality was six. Of the cases reported the majority occurred from 1892 to 1895.

SCOPOLAMINE HYDROBROMATE AS A MYDRIATIC AND CYCLOPLEGIC.[1]

BY WILLIAM S. FOWLER, M.D., CHICAGO.

OVER two years ago my attention was called to scopolamine hydrobromate as a cycloplegic and mydriatic, and accepting the statement of the manufacturing chemist Merck, that this agent was ten times more powerful than atropia, my first experiments in its use were made with a one-tenth of one per cent. aqueous solution. When this preparation was

[1] Abstract of a paper prepared for the Second Annual Meeting of the Western Ophthalmological, Otological, Laryngological and Rhinological Association, held in St. Louis, April 8-9, 1897.

used as I had been accustomed to use atropia in one per cent. solution (a drop in each eye three times a day for three days), a perfectly satisfactory result was obtained, absolute cycloplegia and complete mydriasis; but the toxic effect of the drug was so marked and the unpleasant and disagreeable symptoms so general that a weaker solution was resorted to; even this was objectionable, the more susceptible individuals showing rapid pulse, dryness of throat, nausea, great weakness, cyanosis of moderate degree with mild delirium, and later, continued nausea; no treatment other than stimulants were necessary. After various reduced solutions had been employed the one-twentieth of one per cent. solution was selected as the standard for practical use in determining the total ametropia in all refractive cases, other proportions being reserved for treatment of diseased conditions and to inaugurate cycloplegia preparatory to the use of some other agent.

In the course of the experiments leading to the conclusions arrived at it was found that one drop of the one-tenth of one per cent. solution would produce mydriasis in about 25 or 30 minutes retaining it *ad maximum* for about 24 hours, the pupil being restored to its normal diameter in from 60 to 80 hours. Cycloplegia was produced in about 40 minutes, retained to full extent from 20 to 30 hours passing off in from 70 to 100 hours, the susceptibility of the individual varying greatly in the length of time the muscle was controlled by the drug; one case required 6 days to re-establish the accommodation function. Much less variation was found in using the one-twentieth of one per cent. solution, but little longer time being required to realize the full action of the solution, and although careful tests were made no increase in intra-ocular tension could be discovered after prolonged use of this strength, neither was there any disturbance of the conjunctiva after the first day and that was too slight to either cause inconvenience or merit mention.

This preparation, one-twentieth of one per cent. solution, has been used in over 600 refractive cases with more freedom than any similar drug in my hands with absolutely no constitutional disturbances, the patients being directed to place one drop in the outer canthi every 15 minutes for one hour (four applications) and return for examination within two hours of the last application. Nursing mothers when using this solu-

tion have failed to discover any untoward symptoms in their nursling.

In diseases or wounds where prompt cycloplegia or mydriasis, or both, has been desired, the one-tenth of one per cent. solution have been used at first, followed by the usual atropine solutions when permanency of action was required.

Comparing the action of the two drugs in a case of iritis, when the patient was in delirium from pain, scopolamine hydrobromate one-tenth of one per cent. solution was dropped in one eye and atropia sulphate, four per cent. solution, in the other, the canaliculi being compressed and the drops being placed in the outer canthi; these drops were repeated every 15 minutes for three applications. At the end of 20 minutes the pupil under scopolamine had become fully dilated, while the one under atropine was not fully dilated, even with this unusual strength of four per cent. at the end of the hour.

When mydriasis alone is required for the purpose of thoroughly examining the fundus and internal media of the globe, one-fortieth or even one-eightieth of one per cent. will produce the result with a minimum amount of inconvenience to the patient, although if the one-twentieth of one per cent. be used a solution of eserine of one-fortieth of one per cent. will hasten the return of the pupil to its normal diameter.

I take pleasure in noting that the results of my experiments agree closely, both as to strength of solution to be used and in the effects noted with those of Dr. Hobbs, of Atlanta, and Dr. Oliver, of Philadelphia, who have already made known their satisfactory results from the use of this comparatively new drug.

In conclusion, the promptness with which complete paralysis of the ciliary muscle can be produced with associated mydriasis and the comparatively rapid return of the parts affected, to their normal condition, together with complete absence of constitutional effects, render the use of this drug most desirable for refraction work when the total ametropia is to be measured, but after cycloplegia and mydriasis have been inaugurated other agents may be better employed if greater permanency of the condition is to be maintained.